

SPATIAL OPERATIONAL DECISION-MAKING FOR REDUCING INEQUALITIES IN ACCESS TO JUSTICE

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Abstract

Alternative Dispute Resolution (ADR) is increasingly recognised as a cheaper, quicker and flexible way of resolving disagreements. ADR uptake has grown significantly across the United Kingdom (UK). The Welsh Government recognises the importance of an agile ADR system. However, there is also broad acknowledgement that a majority of dispute resolution providers are based outside Wales. This article summarises a research programme aimed at investigating the public appetite for setting up dispute resolution centres in Wales, as well as determining the most appropriate locations for such centres. The centres are expected to provide a range of functions for mediators, training providers and those seeking dispute resolution services. The methodology deployed in this study entailed simultaneous location of the dispute resolution centres, and the allocation of composite dispersed demand within a Geographic Information Systems (GIS) framework. This also includes consideration for mobility issues in order to optimise objective functions for the centres. The results from the analysis have enabled stakeholders to establish a justification for the appropriateness of the site(s) selected for the centres. The results also generated an evidence-base to establish how the locations of the proposed centres are likely to affect their success. The broader implications of these analyses and visualisations should be appraised with regard to the propagation of information to positively influence change in reducing inequalities in the population penetration of alternative dispute resolution. The belief is that these techniques can also provide intelligence to validate and exemplify precision in resource allocation. This is of particular relevance to funding intervention initiatives tied to specific community programmes aimed at strengthening equity in access to justice across Wales.

Keywords

Dispute Resolution Service; GIS; Geodemographics; Spatial Analysis; Location-Allocation Modelling; Wales.

1. Introduction

Mediation is one of several processes under the umbrella term 'dispute resolution'. It is an alternative to traditional processes such as courts (litigation) and tribunals (Goldberg et al. 2012). Mediation helps parties to take responsibility for their part in a dispute. Mediation also has the potential to enable parties to reach a more creative outcome, which is more appropriate to them, and offers more healing than a court could (Beck and Sales, 2001). It also goes some way to repair damage to relationships between disputing parties so that they can continue working productively alongside one another (Emery et al. 2005).

Mediation has been present in the UK as a method of dispute resolution for many years but has always been in the shadow of more mainstream processes, for example arbitration and conciliation (McCold, 2006). It is acknowledged that for a significant number of these cases, courts are not the appropriate place, and litigation is not the appropriate process to try to resolve the dispute (Genn et al. 2007). Notwithstanding the expense and duration of that process, litigation can only look at black and white facts of a case and apply the relevant law. Many disputes concern shades of grey, seen from different points of view.

Disputes often involve parties in a wide range of trades and sectors. Therefore, the importance of alternative dispute resolution within the UK justice system cannot be over-emphasised. There is increasing interest in mediation as a way to resolve disputes more efficiently, fairly, and for increased long-term benefit (Liebmann 2000). However, a majority of dispute resolution organisations and services are based outside Wales. Consequently, the Welsh Government commissioned this research study, which seeks to contribute towards understanding the viability and sustainability of setting up dispute resolution centres in Wales. The centres are expected to provide a wide range of functions, which include:

- Promoting and raising awareness of all forms of dispute resolution
- Strengthening accessibility to dispute resolution services and providers
- Improving the quality of providers and dispute resolution services
- Serving as a public arena for sourcing information and signposting potential users of dispute resolution services
- Providing dispute resolution providers with access to training, peer support, best practice and Continuous Professional Development (CPD)

This study responds to the growing need for Alternative Dispute Resolution (ADR) in Wales. While ADR has been known to be cost-saving and efficient, most of the services are located outside Wales, which is a barrier to access. The study evaluates the public interest in establishing dispute resolution centres and determines the optimal locations using location-allocation techniques within a Geographic Information Systems (GIS) environment. The study presents an evidence-based model for justice studies by mapping demand and service gaps and thereby showing the potential for spatial analysis to inform policy. The findings detect inconsistencies in the provision of mediation services and reinforce the need for geographically localised centres to ensure equal access. This research contributes to the overall field of justice studies by employing sophisticated

spatial modelling for legal service allocation. The aim is to help policymakers design an ADR infrastructure that is accessible, efficient and sustainable. The study emphasises the importance of strategic planning in improving access to justice in Wales.

2. Literature Review

Spatial analysis techniques have an important contribution to make to justice research through analysis of the impact of criminal justice policy in specific locations (Peck, 2003). They can help track offender addresses and map them against levels of deprivation to facilitate targeted crime reduction (House of Commons, 2009). Nevertheless, despite its potential, large-scale justice mapping exercises are not a regular feature in the UK (Fox et al. 2013).

2.1 Justice Mapping in the UK

Justice mapping in the UK has been applied primarily to crime prevention and community safety strategies. Houchin's (2005) study on Scottish Prison Services revealed that imprisonment rates were significantly higher in deprived areas, but this was not the case with causal explanations. Crime mapping is frequently employed by Community Safety Partnerships (CSPs) in an effort to identify high-risk areas and to inform crime prevention activity (Chainey 2008; 2013). These projects align with provisions in the Policing and Crime Act 2009, which demand crime reduction strategies at local levels (Tilley and Bullock, 2009).

Justice mapping techniques have been successfully employed by some UK cities where it has historically been used to identify crime hotspots (areas with high concentrations of crime) (Chainey and Ratcliffe, 2005), and local partnerships continue to employ these techniques to improve their crime and disorder reduction strategies by addressing local needs (Tompson et al. 2014). In Newcastle, probation caseload maps located groupings of offenders in deprived wards that were mirrored by broader patterns across the community (House of Commons, 2009). Similarly, Crime and Disorder Reduction Partnerships (CDRPs) designated neighbourhoods as stable, at risk, or priority areas, which initiated targeted crime reduction efforts in Birmingham. Justice mapping has also been employed to analyse crime distribution. Weisburd and Mazerolle (2000) and Weisburd et al. (2004) illustrated that crimes are not distributed evenly across geographic areas. More recently, Wu & Li (2022) developed an algorithm using Kernel Density Estimation (KDE) to detect crime patterns at street level to help the Metropolitan Police Services' Criminal Investigation Department.

2.2 Justice Mapping and Socioeconomic Interventions

Spatial mapping also has uses beyond crime reduction to broader socioeconomic purposes. The Kent 'Supporting Independence' Programme utilised mapping techniques to locate welfare benefit claimants, leading to a 29% higher likelihood of individuals moving off benefits compared to non-targeted areas (SIP, 2002). This evidence aligns with justice

reinvestment practices that advocate geographically targeted local programs to reduce public expenditure.

In the US, GIS mapping has been employed to investigate the intersection of economic policy, criminal justice and social welfare. The Community Justice Project linked offender data with neighbourhood well-being indicators such as jobs and local services (Strom, 2017). Karuppanan (2005) also evaluated correctional resource allocation at a micro-spatial scale, enabling informed investment in crime prevention and rehabilitation.

Cadora et al. (2002) investigated the interaction between socioeconomic determinants and outcomes of justice, introducing the concept of 'million-dollar blocks' - areas where more than a million dollars were invested each year in incarceration and reintegration. These studies highlight how spatial analysis can inform policy decisions to balance investments in punitive measures and social interventions.

2.3 Spatial Analysis in Dispute Resolution

Despite its benefits, justice mapping also faces challenges, particularly regarding data quality and accessibility. For instance, the Greater Manchester Transforming Justice Programme was plagued by low-quality prison data because some prisons were located outside the region (House of Commons, 2009). Data sharing agreements between Wales and England also follow strict geographical boundaries and integration between jurisdictions becomes challenging.

Compared to crime mapping, GIS use in dispute resolution has minimal application. Almeida (2017) utilised a spatial model to categorise tourism conflicts based on Moore's model, arriving at eight conflict typologies. Spatial mapping has also been applied in territorial conflict, such as in the case of the Dayton Accords, where 3D visualisations were employed in an effort to facilitate territorial concessions (Branch 2017). Although studies on the type of spatial location modelling discussed in this article within the criminal justice sector are rare, parallels can be drawn from other fields, such as access to health provision (Farr et al. 2008; Moon et al. 2019). To the best of our knowledge, no study in the UK or internationally has used multi-criteria analysis of spatial demographic and environmental data to determine the optimal sites for dispute resolution centres. This research fills this significant gap by applying spatial modelling for justice accessibility, bridging the fields of justice mapping and dispute resolution.

3. Data and Methods

3.1 Spatial Datasets

In order to develop a proper understanding of the spatial patterns of dispute resolution uptake and supply across Wales, multiple datasets were integrated. A major campaign was launched across Wales to spark interest from numerous dispute resolution providers comprising individuals and organisations. In addition to numerous individual providers who responded directly to the project team, geo-spatial data capture of dispute resolution providers based in Wales was made possible through collaborative engagement with the

Civil Mediation Council, the Chartered Institute of Arbitrators, the Legal Aid Agency, the College of Mediators, Resolution and the Law Society.

The project team was able to secure a robust dataset from the Legal Aid Agency (LAA) with a list of nearly 2,000 postcodes of clients referred for legal aid services. The dataset covered April to October 2013. The project team did not secure data for other types of disputes despite a very painstaking effort. Therefore, throughout this article, we use data for family mediation users, as a proxy for the demand for dispute resolution services.

The third dataset is a geodemographic classification system popularly called Output Area Classification (OAC), which was developed from the UK census conducted in 2011 (Gale et al. 2016). Geodemographics play a significant role in dispute resolution by identifying high-demand areas for mediation services. Spatial analysis within a geodemographic framework helps to facilitate more equitable resource allocation by analysing the distribution of people, socioeconomic status and accessibility. This can in turn help policymakers strategically position centres for dispute resolution, improving justice service accessibility and equity among communities.

OAC is a recognised national statistic (Vickers and Rees, 2007) and it serves as the main descriptor of neighbourhood characteristics in this article. The OAC groups together small geographic areas according to key characteristics common to the population in that group. These groups are referred to as clusters and were derived from spatial-statistical manipulation of census data using a technique called cluster analysis. The OAC places each 2011 UK census OAs into one of eight clusters called Supergroups based on the socio-economic attributes of the residents of each area. As shown in Table 1, the eight

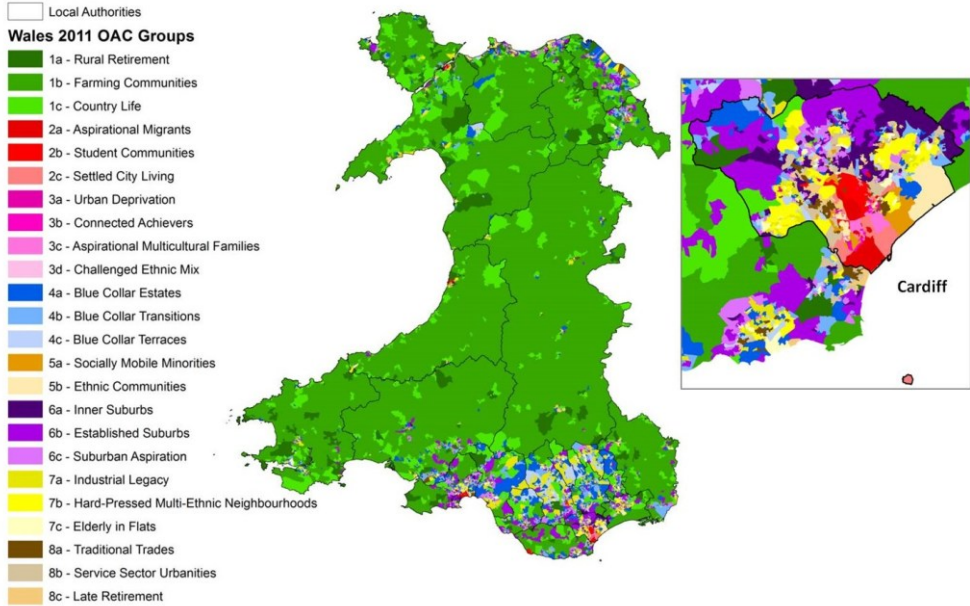
Supergroups are further subdivided into 24 Groups and these are finally sub-divided into 67 Subgroups.

Table 1: Hierarchical Structure of the 2011 ONS Output Area Classification

The analysis in this article is conducted using the second hierarchy of OAC. A map of the OAC Groups in Wales is shown in Figure 1 with Cardiff inset. The map was produced for the 10,036 OAs in Wales.

<u>Super-groups</u>	<u>Groups</u>
1: Rural Residents	1a: Rural Retirement
	1b: Farming Communities
	1c: Country Life
2: Cosmopolitans	2a: Aspirational Migrants
	2b: Student Communities
	2c: Settled City Living
3: Ethnic Mix	3a: Urban Deprivation
	3b: Connected Achievers
	3c: Aspirational Multicultural Families
	3d: Challenged Ethnic Mix
4: Blue Collar Neighbourhoods	4a: Blue Collar Estates
	4b: Blue Collar Transitions
	4c: Blue Collar Terraces
5: Multicultural Metropolitans	5a: Socially Mobile Minorities
	5b: Ethnic Communities
6: Suburbanites	6a: Inner Suburbs
	6b: Established Suburbs
	6c: Suburban Aspiration
7: Hard-Pressed Households	7a: Industrial Legacy
	7b: Hard-Pressed Multi-Ethnic Neighbourhoods
	7c: Elderly in Flats

8: Urbanites	8a: Traditional Trades
	8b: Service Sector Urbanities
	8c: Late Retirement



3.2 Calibrating the Geographical Scale of Demand for Dispute Resolution Services

Quantifying the level of demand for dispute resolution services across geographical space in Wales is not a straightforward task. One of the reasons for this is that there are different types of dispute resolution services. Mediation for family disputes is the preferred type of dispute resolution when a disagreement involves immediate or extended members of a family (Stevenson, 2000). This sort of mediation can be particularly beneficial in scenarios where the relationship between the parties is likely to continue beyond the resolution of the dispute. Other types of dispute resolution services fall broadly under civil mediation. These could include for instance the resolution of housing issues, business disputes, small claims, debt claims, boundary disputes, employment disputes, contractual disputes, personal injury and negligence claims, and community disputes such as nuisance or harassment issues (Liebmann, 2000).

$$Demand\ Index = \left[\left(\frac{n}{\sum_1^k n} \right) \div \left(\frac{N}{\sum_1^k N} \right) \right]$$

Where,

n is count of people referred to the LAA for legal aid service in geodemographic typology k

N is count of adult population in geodemographic typology k

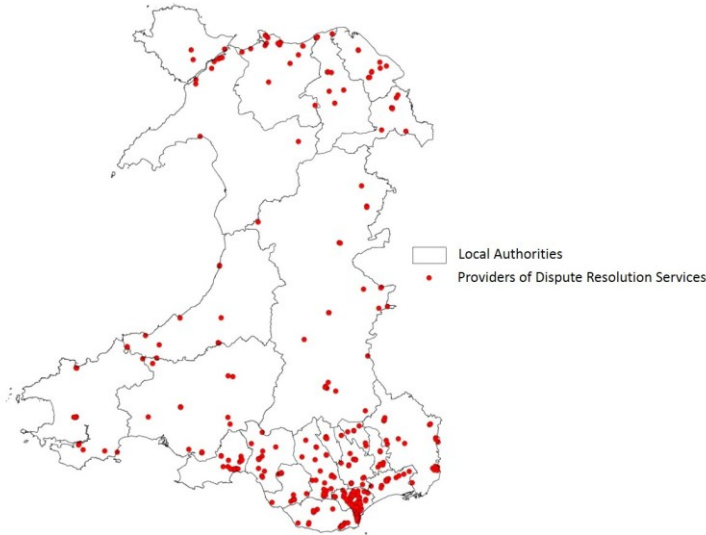
k is total number of geodemographic typologies

Due to the fact that there are individual and organisational providers of dispute resolution services, data relating to the level of usage is not generally stored centrally. For this study, the data used as a proxy for demand for dispute resolution services was a record of persons who had been referred to the LAA for legal aid service in order to resolve a family dispute. Anonymised postcode data was made available for the period April to October 2013. The dataset was carefully cleaned and geo-coded. A total of 1,755 records were successfully geo-coded. All geo-coded postcodes were linked to their corresponding geodemographic typologies to allow for further profiling. A demand index value was calculated for each geodemographic typology using the notation shown in Equation 1 such that an index score of 100 indicates a level of occurrence of demand for dispute resolution services equal to the national mean or expected level. An area with an index of 150 would indicate a level 50% above the national average and a score of 200 twice the expected rate (Harris et al. 2005; Ojo, 2020).

3.3 Modelling the Spatial Density of Supply Dispute Resolution Services

There are individual and organisational providers of dispute resolution services in Wales. Therefore, it was impossible to secure data about their locations from a single source. For this study, information regarding the provision of dispute resolution services was derived from multiple sources. With the assistance of the project steering group and a number of organisations, a database was developed comprising a wide range of individuals and organisational providers of dispute resolution services. The collation of this database was made possible through collaborative engagement with the Civil Mediation Council; The Chartered Institute of Arbitrators; The Legal Aid Agency; The College of Mediators; Resolution; and The Law Society. The dataset was carefully cleaned and geo-coded. A total of 394 unique records were successfully geo-coded as shown in Figure 2. All the geo-coded

postcodes were linked to their corresponding geodemographic typologies to allow for further profiling.



A non-parametric model - Kernel Density Estimation (KDE) was used to calibrate the density of the point features (Okabe et al. 2009). Spatial social science applications of KDE are based on spatially extensive variables such as socio-economic data. The technique has been used to measure spatial accessibility to services by comparing the densities of supply and demand in a given area in order to detect uneven distributions of services (McClafferty and Grady 2004). We used the notation given in Equation 2 to compute the KDE.

$$\hat{f}(x_0) = \frac{1}{nh} + \sum_i K\left(\frac{x_i - x_0}{h}\right)$$

Where,

x_0 is the point for which local neighbourhood density will be estimated

h is a smoothing parameter which controls the size of the neighbourhood around x_0

K is a function called the kernel, and it controls the weight given to the observations $\{x_i\}$ at each point $\{x_0\}$ based on their proximity

One of the strengths of the KDE is that it avoids the discontinuities in the estimated density function. Rather than assigning equal weights to every point within the study area, the estimator assigns weights, which diminish towards zero, as the distance gets further away from the target point x_0 (Roig-Tierno et al. 2013). Rather than assuming distribution pattern based on prior knowledge (e.g., exponential or chi-square distributed), KDE estimates the probability density function from the characteristics of the data sample itself through density calculations based on user-defined search bandwidth and kernel functions. There are several KDE functions but for this study, we used the Gaussian

(Normal) Kernel function which is well suited for general-purpose density estimation, also effective for large datasets with normal distribution. The bandwidth (smoothing parameter, h) was determined using Silverman's Rule-of-Thumb (ROT) method which is effective for approximately normal data.

3.4 Calculating Inequalities in the Provision of Dispute Resolution Services

The concentration index (CI) has been used here to illustrate the proportion of inequality in the distribution of providers in relation to the adult population. The CI is a useful metric for assessing inequalities because it incorporates the experiences of the entire population and it is sensitive to changes in how population is distributed across socio-economic groups (Koolman and Van Doorslaer 2004). The CI is algebraically defined in Equation 3.

$$CI = \frac{1}{2} \sum |x_i - y_i| \quad (3)$$

Where,

CI is the index of concentration

x_i is the proportion of dispute resolution providers in geodemographic cluster i

y_i is the proportion of adults in geodemographic cluster i

A CI equal to zero would signify equilibrium in the system - a scenario whereby the proportion of adults in each neighbourhood type had a corresponding proportional share of dispute resolution service providers. A CI equal to 100 would indicate complete inequality – a scenario where all of the dispute resolution service providers are situated in just one neighbourhood type.

3.5 Multi-criteria Location-Allocation Modelling

Location is an important factor that often influences the success or failure of public or private services. A poor location decision can be difficult and expensive to overcome. Both private and public sector organisations can profit from a good location. The choice of a good location can mean for instance that high quality public services can be delivered to the community in a cost-effective manner.

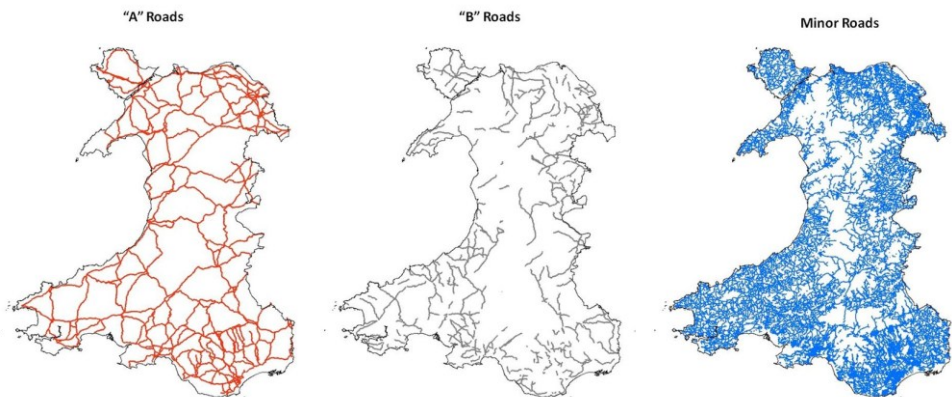
There is much to consider when deciding on the location of a business or service. The parameters for consideration depend on the function expected of the site and the availability of required data for quantifying the assumptions and expectations of the site. We used a location-allocation modelling technique (Chang, 2018) to determine the probable sites for the dispute resolution centres such that they are able to supply the likely points of demand in a very efficient manner. The modelling approach is two-fold: the simultaneous location of sites for the centres and the dispersal of likely demand to each of the chosen centres.

3.5.1 Model Parameters, Assumptions and Specification

Within this spatial modelling context, location indicates the process of identifying optimum sites for the proposed centres given a set of objectives related, for instance, to accessibility. The term allocation on the other hand represents the process of identifying specific neighbourhoods and dispute resolution service providers surrounding the centres that should serve the centres concerning the in- or outflow of people. This is generally known as demand (Church, 1999).

Road Network

It is assumed that people will mostly travel to the proposed centres by road. Therefore, digital road network data for Wales was used. The assumption is that people will travel via A, B, and minor roads. Figure 3 shows the separate road networks. It is recognised that many people may not have access to car therefore cost of journey might be important. The work of Comber et al. (2011) considered this. However, due to lack of available data, it was not possible to incorporate cost of journey information.



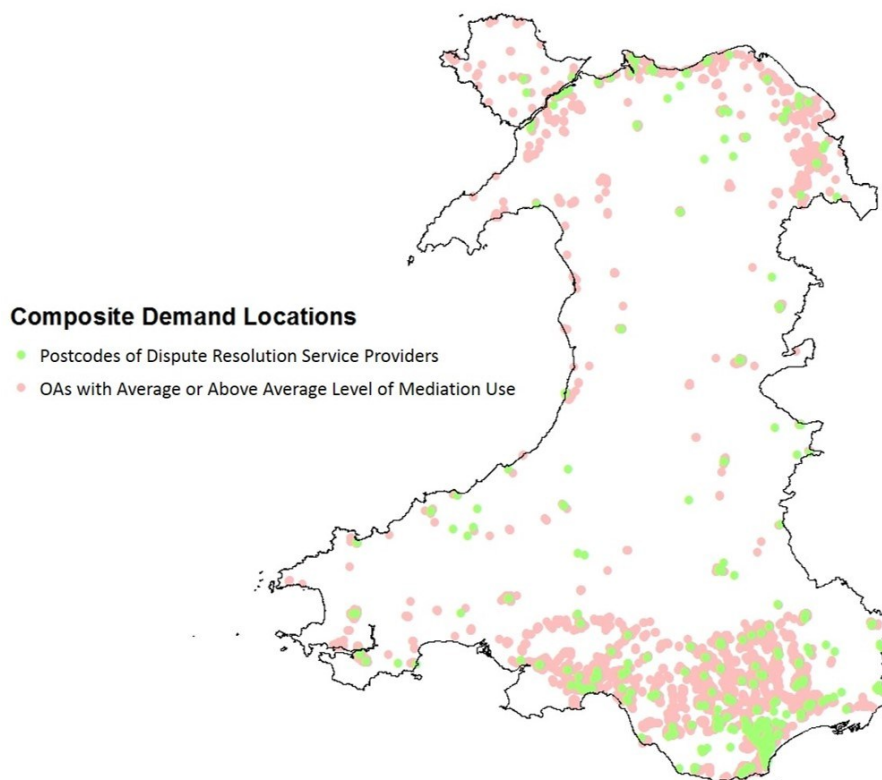
Impedance

The framing of a location-allocation model entails network analysis. During the network analysis process, an important goal is often to minimise a cost during the calculation of the possible path of travel from demand points for instance (Church and Sorensen 1994). This cost is also known as impedance. Our model assumed that those who would visit the centres would prefer to travel via the shortest possible route. Therefore, their aim would be to minimise the distance covered. Distance was therefore used as the impedance parameter in the analysis. We assumed that users of these centres may not want to travel beyond 7 miles based on the average trip length reported by the Department for Transport (DfT, 2013). This is of course a relative value as some users may choose to do longer distances.

Composite Demand

The dispute resolution centres are expected to provide a wide range of functions for mediators, training providers and those seeking meditation services. This implies that two groups will use the centres. These include dispute resolution providers and those people

seeking their services. The methodological approaches for estimating those two demands are described in Sections 3.2 and 3.3 of this article. The relative likelihood for adults to use dispute resolution services was modelled for the 10,036 Output Areas in Wales. All Output Areas received a weight (the demand index for which the Welsh national average is 100). We also identified the spatial distribution of 394 dispute resolution service providers. Each provider was given the same weight equal to the national average of 100.



A composite of demand of locations for the proposed dispute resolution centres was generated by combining both sets of data (i.e. the Output Areas with an above average or national average level of dispute resolution usage and the postcodes of service providers) to give a combined total of 6,368 possible weighted demand points. Figure 4 shows the spatial distribution of the composite demand points.

Candidate Locations

The next parameter in the model specification is the set of locations from which a sub-set of optimal sites could be chosen (Church, 1999). It was decided that in the spirit of equity, every Ward in Wales should be given an equal opportunity of being selected as potential sites for dispute resolution centres having simultaneously considered the road network, factors of attractiveness and impedance.

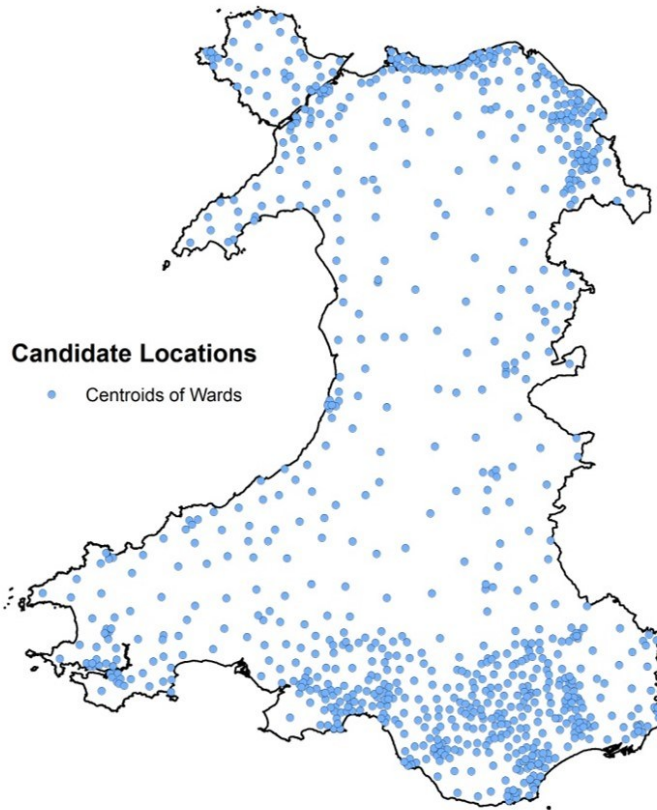


Figure 5 shows the spatial distribution of the centroids of all the 881 Wards in Wales. These are the candidate locations.

Location-allocation Problem Type and Model Specification

There are several primary problem types in the discipline of discrete location theory (Kuldeep et al. 2017). These problems (often described as location-allocation problems) determine the location of potential sites for situating services or facilities and allocating demand points to one or more of the sites. The problem type that this research study seeks to solve is the maximise attendance problem type. This problem type helps to choose potential sites for the dispute resolution centres such that as much demand weight as possible is allocated to the sites while assuming the demand weight decreases in relation to the distance between the site and the demand points (Church, 2002). One of the assumptions here is that distance may create some frictional effects on the attractiveness of sites to potential users. The maximise attendance problem type used in this study therefore assumes that the farther people have to travel to reach the dispute resolution centres, the less likely they are to use it.

4. Results and Discussion

4.1 Geographical Variations in Demand

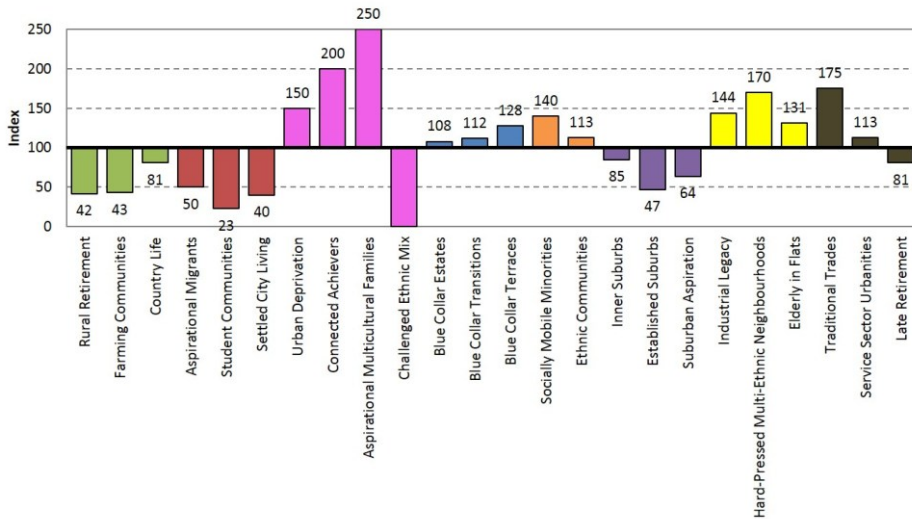
The increasing use of dispute resolution practitioners across Wales and the UK is well-documented (Hann et al. 2019). Mediation and similar processes have been integrated into numerous legal and quasi-legal contexts. However, prior to this study, the spatial distribution of demand for dispute resolution services in Wales remained unclear. Understanding this spatial intensity is crucial for effectively situating service centres to benefit users.

Table 2: Relative Likelihood for Adults to Use Family Dispute Resolution Services by 2011 OAC Classification Groups

Group Codes	Group Labels	Demand Index
1a	Rural Retirement	42
1b	Farming Communities	43
1c	Country Life	81
2a	Aspirational Migrants	50
2b	Student Communities	23
2c	Settled City Living	40
3a	Urban Deprivation	150
3b	Connected Achievers	200
3c	Aspirational Multicultural Families	250
3d	Challenged Ethnic Mix	0
4a	Blue Collar Estates	108
4b	Blue Collar Transitions	112
4c	Blue Collar Terraces	128
5a	Socially Mobile Minorities	140
5b	Ethnic Communities	113
6a	Inner Suburbs	85
6b	Established Suburbs	47
6c	Suburban Aspiration	64
7a	Industrial Legacy	144
7b	Hard-Pressed Multi-Ethnic Neighbourhoods	170
7c	Elderly in Flats	131
8a	Traditional Trades	175
8b	Service Sector Urbanities	113
8c	Late Retirement	81

Table 4 and Figure 6 present data from the comparative model, which relates the rates of persons referred for legal aid in a family mediation context to adult population rates across different geodemographic typologies. The generated demand indices indicate that 'Aspirational Multicultural Families' are significantly more likely to seek dispute resolution services, with usage rates more than double the national average for Wales.

Residents of 'Aspirational Multicultural Families' typically live in semi-detached or terraced houses, with some in detached houses. These households are primarily socially rented, though some are privately rented. The neighbourhoods have below-average numbers of residents born in EU countries. These residents often have medium to low-level qualifications and are likely employed in the primary or secondary sectors, using private transport for commuting.



Another group with a high demand for dispute resolution services is the 'Connected Achievers Group', which also shows usage rates around double the national average. These neighbourhoods have an above-average number of young adults who generally live in semi-detached or terraced houses, either owned or privately rented. This group has a higher-than-average number of residents born in EU countries, possesses high-level qualifications, and is predominantly employed full-time in the tertiary sector, using public transport to commute.

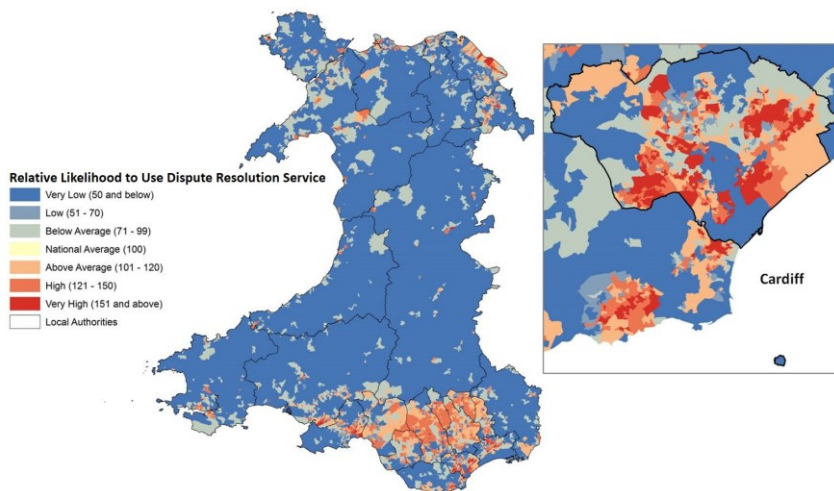


Figure 7 illustrates the spatial distribution of adults likely to use dispute resolution services, highlighting that extensive areas in South Wales have a high propensity for such services. Two additional neighbourhood types-'Traditional Trades' and 'Hard-Pressed Multi-Ethnic Neighbourhoods'-also exhibit a strong likelihood of utilising dispute resolution services.

'Traditional Trades' neighbourhoods typically consist of younger residents, with few over retirement age. The ethnicity in these areas is mixed but predominantly white. Residents usually live in rented or owned terraced housing, which may lack central heating. These individuals tend to have lower-level qualifications and significant levels of unemployment. Employed residents often work in the primary or secondary sectors and are likely to walk, cycle, or use non-standard public or private transport for commuting.

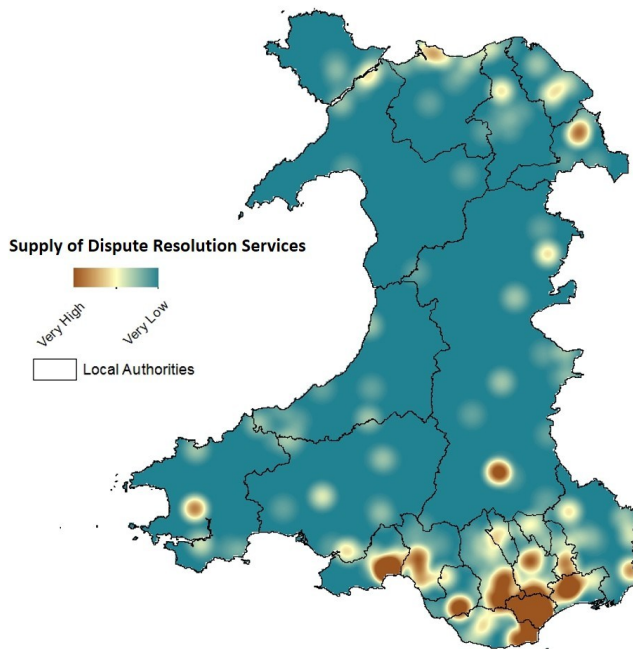
'Hard-Pressed Multi-Ethnic Neighbourhoods' feature an above-average number of children over 16 years in full-time education. These areas have a higher likelihood of unemployment, though employed residents typically work in the secondary or tertiary sectors and rely on public transport for commuting.

The spatial analysis indicates that specific neighbourhood typologies in Wales have distinct demand patterns for dispute resolution services, influenced by socioeconomic and demographic factors. These findings underscore the importance of geographically targeted service centres to address local needs effectively, ultimately enhancing access to dispute resolution services across diverse communities.

4.2 Distribution, Inequalities and Gaps in Supply

Ensuring equitable access to legal services is a crucial obligation for the Welsh Government (Williams, 2004), further emphasised by the stipulations of the Human Rights Act. In the mixed economy of legal advice provision, contemporary policy debates often focus on delivering services that meet people's needs, offer choice, ensure access, and appropriately address daily life problems.

Dispute resolution is more than a process; it encompasses a set of skills and an approach to problem-solving (Goldberg et al. 2012). While established legal firms can more easily integrate dispute resolution services into their offerings, developing in-house dispute resolution services can be challenging. Furthermore, the lack of nationally recognised standards for mediation and the absence of mediation training on the Qualifications Curriculum Authority's agenda complicate the supply of dispute resolution services. Several accredited mediation training courses exist, accredited by institutions such as the Institute of Leadership and Management (ILM), Oxford, Cambridge and RSA Examinations (OCR), and the Open College Network (OCN). These factors collectively impact the provision of dispute resolution services.



Using the KDE model described previously, Figure 8 illustrates the spatial density of dispute resolution service providers, revealing significant concentrations of hotspots. Notably, local authorities such as Cardiff, Rhondda Cynon Taf, The Vale of Glamorgan, Newport, Bridgend, Swansea, Neath Port Talbot, Powys, Caerphilly, Wrexham, and Pembrokeshire exhibit disproportionate concentrations of these providers.

Table 3 presents a comparative analysis of dispute resolution service providers by the neighbourhood types in which they are located. The findings indicate that 'Traditional

Trades' and 'Late Retirement' neighbourhoods together account for approximately one-quarter of these providers.

These results highlight the uneven distribution of dispute resolution services across Wales, underscoring the need for strategic planning to ensure equitable access. Addressing these disparities is essential for fulfilling the Welsh Government's obligation to provide accessible legal services and for enhancing the overall effectiveness of dispute resolution mechanisms in meeting the needs of diverse communities.

Table 3: Comparative Distribution of Dispute Resolution Service Providers by 2011 OAC Groups

Group Codes	Group Labels	Share of Dispute Resolution Service Providers (%)	Adult Population Penetration (Providers per 1000 adults)
1a	Rural Retirement	2.3	0.12
1b	Farming Communities	7.9	0.13
1c	Country Life	5.6	0.12
2a	Aspirational Migrants	6.6	2.56
2b	Student Communities	4.8	0.24
2c	Settled City Living	2.5	0.79
3a	Urban Deprivation	0.5	0.4
3b	Connected Achievers	0.3	0.33
3c	Aspirational Multicultural Families	1	0.72
3d	Challenged Ethnic Mix	0	0
4a	Blue Collar Estates	5.6	0.07
4b	Blue Collar Transitions	5.3	0.14
4c	Blue Collar Terraces	2.8	0.06
5a	Socially Mobile Minorities	0.5	0.17
5b	Ethnic Communities	0.3	0.05
6a	Inner Suburbs	2.8	0.22
6b	Established Suburbs	7.4	0.16
6c	Suburban Aspiration	2.8	0.05
7a	Industrial Legacy	4.3	0.04
7b	Hard-Pressed Multi-Ethnic Neighbourhoods	3	0.1
7c	Elderly in Flats	5.8	0.25
8a	Traditional Trades	14.7	0.65
8b	Service Sector Urbanities	2.8	0.29
8c	Late Retirement	10.4	0.8

Traditional Trades communities are typically characterised by a younger demographic, with

a low likelihood of residents being over retirement age. While the ethnic composition is mixed, the majority of residents are likely to be white. These individuals commonly live in rented or owned terraced housing, often lacking central heating. Higher-level qualifications are less common among this group. Employed residents are predominantly found in the primary or secondary sectors and tend to walk, cycle, or use alternative forms of transport for commuting. This demographic profile aligns with communities identified in Section 3.2 as having a high demand for dispute resolution services.

Conversely, Late Retirement communities are predominantly composed of older individuals, with a significant number of residents being over retirement age. These communities have low ethnic diversity, with a higher likelihood of white residents. Housing typically consists of flats, either owned or rented, often within communal establishments. Residents are more likely to experience poor health and may provide unpaid care. Employment, when present, is often in the hospitality sector, with walking, cycling, or alternative transportation modes used for commuting. Additionally, residents in these communities have an increased likelihood of maintaining a second address.

Table 3 reveals a disproportionate concentration of dispute resolution providers relative to the adult population within the Aspirational Migrants neighbourhood typology. For every thousand adults in these areas, there are over two dispute resolution service providers. Aspirational Migrants neighbourhoods are primarily inhabited by young, ethnically diverse adults, with households less likely to include school-age children or individuals speaking English or Welsh as their primary language. Residents are more likely to live in privately rented flats, possess higher-level qualifications, be employed full-time in the tertiary sector, and use public transport for commuting.

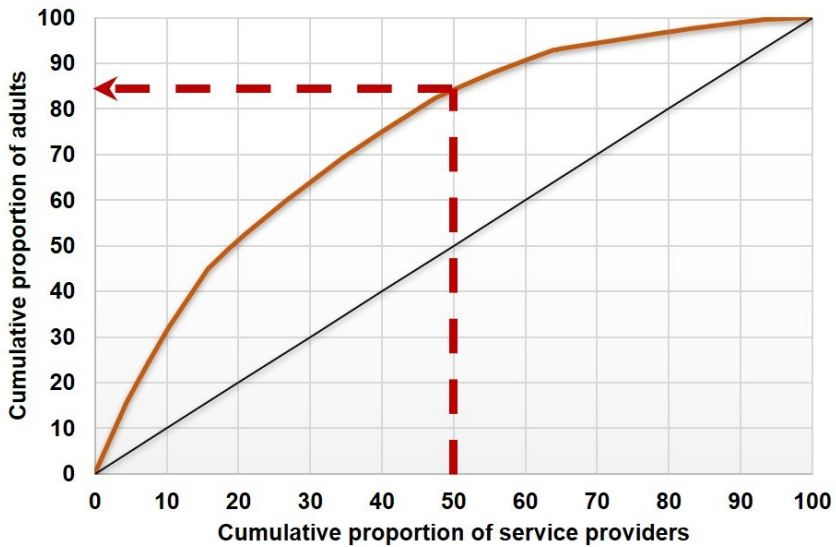
These findings highlight the need for targeted distribution of dispute resolution services, taking into account the unique demographic and socioeconomic characteristics of different neighbourhood types. Ensuring equitable access to these services requires a nuanced understanding of community profiles and their specific needs, which this study contributes to by identifying areas with high potential demand and existing service concentrations.

Table 4: Comparative Distribution of Dispute Resolution Service Providers by 2011 OAC Groups

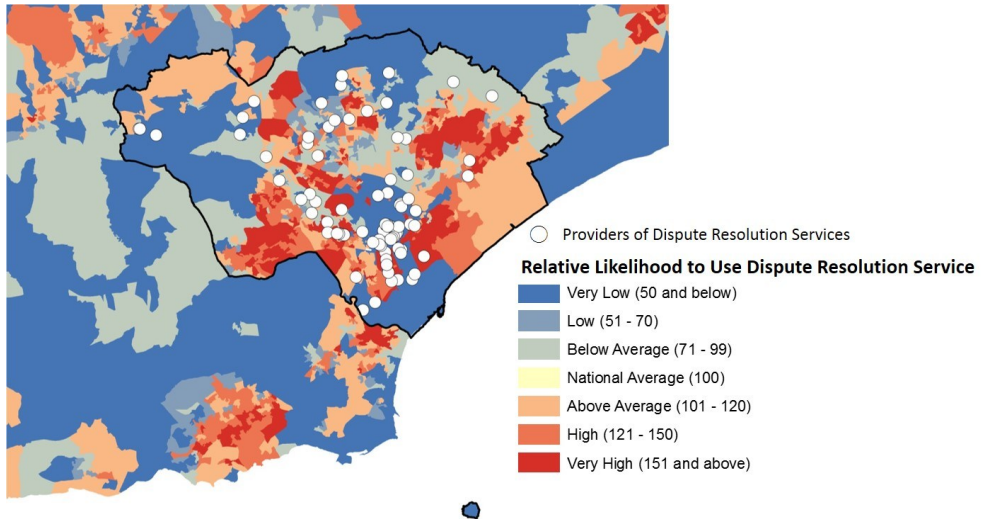
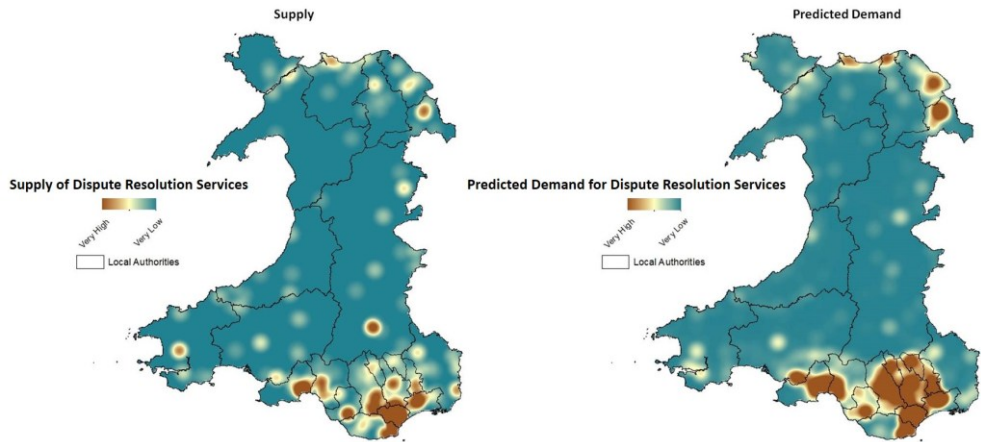
Group Codes	Group Labels	Adult Population Penetration (Providers per 1000 adults)	x_i	y_i	$ x_i - y_i $	Cumulative (x_i)	Cumulative (y_i)
3d	Challenged Ethnic Mix	0	0	0	0	0	0
7a	Industrial Legacy	0.04	4.3	15.5	11.2	4.3	15.5

5b	Ethnic Communities	0.05	0.3	0.8	0.5	4.6	16.3
6c	Suburban Aspiration	0.05	2.8	8	5.2	7.4	24.3
4c	Blue Collar Terraces	0.06	2.8	7.8	5	10.2	32.1
4a	Blue Collar Estates	0.07	5.6	12.8	7.2	15.8	44.9
7b	Hard-Pressed Multi-Ethnic Neighbourhoods	0.1	3	4.7	1.7	18.8	49.6
1a	Rural Retirement	0.12	2.3	3.1	0.8	21.1	52.7
1c	Country Life	0.12	5.6	7.2	1.6	26.7	59.9
1b	Farming Communities	0.13	7.9	9.3	1.4	34.6	69.2
4b	Blue Collar Transitions	0.14	5.3	5.8	0.5	39.9	75
6b	Established Suburbs	0.16	7.4	7.2	0.2	47.3	82.2
5a	Socially Mobile Minorities	0.17	0.5	0.5	0	47.8	82.7
6a	Inner Suburbs	0.22	2.8	2	0.8	50.6	84.7
2b	Student Communities	0.24	4.8	3.1	1.7	55.4	87.8
7c	Elderly in Flats	0.25	5.8	3.6	2.2	61.2	91.4
8b	Service Sector Urbanities	0.29	2.8	1.5	1.3	64	92.9
3b	Connected Achievers	0.33	0.3	0.1	0.2	64.3	93
3a	Urban Deprivation	0.4	0.5	0.2	0.3	64.8	93.2
8a	Traditional Trades	0.65	14.7	3.6	11.1	79.5	96.8
3c	Aspirational Multicultural Families	0.72	1	0.2	0.8	80.5	97
2c	Settled City Living	0.79	2.5	0.5	2	83	97.5
8c	Late Retirement	0.8	10.4	2.1	8.3	93.4	99.6
2a	Aspirational Migrants	2.56	6.6	0.4	6.2	100	100

In Table 4, we show some of the results from the analysis of the concentration index. The table features cumulative percentages of the shares of providers (x_i) and adult population (y_i). The results from the analysis yielded a concentration index of 35.1 suggesting that 35% of dispute resolution service providers would need to be redistributed across different neighbourhood types in order to produce an exact correspondence between dispute resolution service providers and adult population need.



Further analysis of the data, depicted in Figure 9, utilises a concentration curve similar to the Lorenz curve. This curve is based on the cumulative proportions of dispute resolution service providers and adult populations from the last two columns of the table. The geodemographic clusters are arranged in ascending order of adult penetration rates per 1,000 adults. Observing the cumulative proportions reveals that approximately 40% of dispute resolution providers are situated in neighbourhoods housing three-quarters of the adult population in Wales. This disparity can be better understood by comparing the density map of dispute resolution service providers with a corresponding density map of predicted demand for mediation services.



As detailed in Section 3.2, predicted dispute resolution demand indices were generated for all Output Areas in Wales and used to create a density surface via the KDE methodology. Figure 10 presents the spatial density surface of both the supply of dispute resolution services and the predicted demand. The maps exhibit similar patterns in terms of hot and cold spots, indicating that dispute resolution providers are generally located in neighbourhoods where there is a high demand for these services. This finding not only explains some neighbourhood disparities in the supply of dispute resolution services but also validates our predictive model for estimating demand.

Despite the alignment of supply and demand, there is still a notable need for increased service coverage in relation to demand hotspots. For example, Figure 11 illustrates demand-

supply gaps in Cardiff, showing the exact locations of various service providers overlaid on the predicted demand indices for Output Areas in the local authority. This visual representation highlights areas where the supply of dispute resolution services does not fully meet the predicted demand, emphasising the need for strategic placement of additional resources to ensure equitable access.

4.3 Distribution, Inequalities and Gaps in Supply

Our discussion now shifts toward results from the location-allocation model which was also done within the GIS environment. The aim was to select a sub-set of 10 potential Wards from all the 881 Wards in Wales. After deploying the algorithm, the Wards shown in Table 5 were selected as optimal locations for the dispute resolution centres. Nine of the wards are located in South Wales. Only one of them (Offa) is located in the northern half of the country.

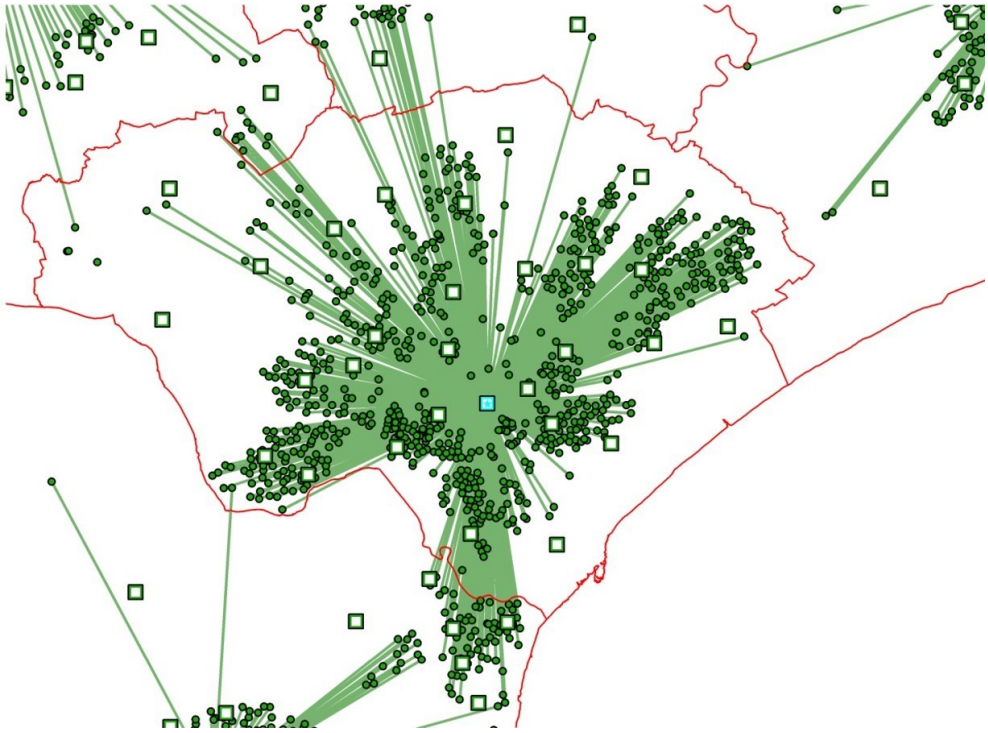
Table 5: Coverage of Optimal Locations

Optimal Wards	Local Authority	Demand Weight	Demand Count
Cathays	Cardiff	61504	825
Stow Hill	Newport	41438	549
Cwmbwrla	Swansea	37343	431
Cefn Fforest	Caerphilly	22684	367
Offa	Wrexham	22597	285
Rhondda	Rhondda Cynon Taf	22418	423
Neath East	Neath Port Talbot	19143	287
Buttrills	The Vale of Glamorgan	18334	171
Bigyn	Carmarthenshire	17577	207
Twyn Carno	Caerphilly	17196	316

Table 5 presents a summary of key features for each optimal location after applying the modelling heuristics. The demand weight column indicates the scale of demand assigned to each optimal location, based on the cumulative likelihood indices for each demand point assigned to the corresponding ward. A higher demand weight value suggests a higher expected usage level for the chosen location (Church, 1999).

The demand count column shows the number of demand points allocated to each corresponding ward. In this analysis, demand points represent a composite of neighbourhoods/Output Areas and dispute resolution service providers. For instance, Table 5 reveals that with an average trip length of 7 miles, those most likely to use a dispute resolution centre in Cathays could come from approximately 825 neighbourhoods and service providers. Spider diagrams, or desire lines, illustrate the neighbourhoods and providers likely to visit a dispute resolution centre.

Spider diagrams were generated for the ten optimal wards listed in Table 5. For this article, we focus on the optimal ward chosen in Cardiff, depicted in Figure 12. Cathays is the optimal ward in Cardiff. The analysis indicates that most users of a centre in this location are likely to come from within Cardiff. However, based on the model parameters, a centre in Cathays could also attract users from the Vale of Glamorgan and Caerphilly.



In Newport, the optimal ward is Stow Hill. The analysis suggests that the majority of users for a centre in this location would come from Newport. However, it could also attract users primarily from Torfaen and a small portion from Caerphilly. In Swansea, Cwmbwrla is the optimal ward. The analysis indicates that most users would come from within Swansea, with minimal patronage from adjoining local authorities. In Caerphilly, Cefn Fforest is the first optimal ward. Most users would likely come from within Caerphilly, but the centre could also draw users from Blaenau Gwent and some neighbourhoods in Merthyr Tydfil. The second optimal ward in Caerphilly is Twyn Carno. The analysis suggests that most users would come from outside Caerphilly, specifically from Blaenau Gwent and Merthyr Tydfil. In Wrexham (and north Wales), Offa is the optimal ward. Most users would be drawn from within Wrexham. In Rhondda Cynon Taf, Rhondda is the optimal ward. The analysis indicates that most users would come from Rhondda Cynon Taf and some neighbourhoods in Caerphilly. In Neath Port Talbot (and north Wales), Neath East is the optimal ward. Most users would come from within Neath Port Talbot.

In the Vale of Glamorgan, Buttrills is the optimal ward. Most users would come from within the Vale of Glamorgan. In Carmarthenshire, Bigyn is the optimal ward. The analysis suggests that most users would come from Carmarthenshire, but the centre could also attract users

from Swansea.

These findings highlight the importance of strategically situating dispute resolution centres to maximise accessibility and usage. The results also validate the predictive model used in this study, offering a robust framework for future planning and resource allocation in the realm of dispute resolution.

5. Implications and Conclusion

The study described in this paper shows that local level disparities exist in the levels of demand for and supply of mediation services in Wales. The study has further exposed spatial patterns of the rates at which the adult population in Wales make use of dispute resolution services. This paper has also demonstrated that the development and application of modelling techniques such as those used in this study can be helpful in interpreting geographically referenced datasets for the Justice and Community Safety sector in Wales and constructing specialised and bespoke solutions.

The results show that dispute resolution demand is more or less likely to be correlated with different community types enabling the identification of special population groups. The location-allocation modelling technique used to choose optimal locations is based on a wide range of parameters and assumptions. Among the ten optimal Wards which were chosen with the hope of maximising attendance at the proposed centres, only one is situated in the Northern half of the country. The research underpinning this paper clearly highlights that there is a demand for dispute resolution services, but the supply side needs some attention. It requires concerted effort from policymakers and stakeholders to ensure it can emerge from the shadow of established, mainstream offers such as arbitration and conciliation. However, it is acknowledged that there are complexities and challenges, which need to be addressed in order to deliver a successful service, for example, in relation to geographies and finance, as evidence suggests that success is tied into both the location of the proposed centres and the necessary funding to support such ventures. For example, Zhao & Chen (2024) show that digital infrastructure and funding are critical for access in less-served geographies, while the ADB's experience in development financing of dispute resolution reform projects indicates that small, well financed reforms with strong local ownership outperform larger, poorly funded initiatives (Nagpal and Pak, 2019).

Much of the interest in a dispute resolution service was found in a wide range of stakeholders (who might be involved in delivering or shaping such a service) including mediators, businesses, professional organisations such as the Advisory, Conciliation and Arbitration Service (Acas), Chartered Institute of Arbitrators (CIArb), the Civil Mediation Council (CMC), law firms and barristers' chambers. Priorities for such a service focused on promotion of the offer and raising awareness of all forms of dispute resolution, accessibility and improving the quality of mediators. The latter is underpinned by the fact that the right skills need to be developed and these must be governed by appropriate recognised standards for mediation.

The topic of mediation and dispute resolution has provided the Welsh government with

food for thought. This is evidenced in the narrative found within the oral evidence session conducted by the Commission on Justice in Wales earlier this year.¹ Important issues were raised in this discussion, many of which echoed the findings of this study:

- There is clearly an appetite and a place for mediation/dispute resolution
- Accreditation and standards would support development
- Geography/location is important in achieving success
- Courts and tribunals need to make better use of dispute resolution
- There is a lack of understanding about dispute resolution amongst the public and information is scarce
- Better partnerships need to be developed between the public and private sectors and the court service
- Local government could be encouraged to make more use of dispute resolution

The above points reinforce the findings of the study, which contends that dispute resolution is an ‘immature’ industry, trying to find its feet. In order to ‘mature’ this industry, policy makers and stakeholders, need to address these challenges to ensure that dispute resolution can be properly established, developed and run as a business-type model which can compete in the marketplace.

The spatial analysis identified distinct demand patterns for dispute resolution services across various neighbourhood types in Wales, influenced by socioeconomic and demographic factors. These insights underscore the necessity of geographically targeted service centres to effectively address local needs and enhance access to dispute resolution services across diverse communities. The study reveals an uneven distribution of these services, emphasising the importance of strategic planning to ensure equitable access.

Addressing these disparities is crucial for the Welsh Government to meet its obligation to provide accessible legal services, thereby improving the effectiveness of dispute resolution mechanisms for diverse populations. The geodemographic analysis demonstrates the need for a targeted distribution of services, tailored to the unique demographic and socioeconomic profiles of different neighbourhoods.

These findings advocate for the strategic positioning of dispute resolution centres to maximise accessibility and usage. This study contributes to a more equitable distribution of services across Wales by aligning service provision with areas of highest demand. This can help to ensure that dispute resolution services are accessible to most communities, fulfilling both legal obligations and enhancing overall service effectiveness.

6. Data Availability Statement

The data analysed in this study were a re-analysis of existing data, which are openly available at the Office for National Statistics (ONS) and the Ordnance Survey (OS) open data repositories [ONS: <https://digitalblog.ons.gov.uk/category/opendata/>; OS:

¹ <https://llyw.cymru/sites/default/files/publications/2019-03/Oral%20evidence%20to%20the%20Commission%20on%20Alternative%20Dispute%20Resolution.pdf>

<https://www.ordnancesurvey.co.uk/business-government/tools-support/open-data-support>]. Additional data analysed in this study are not publicly available because of their sensitive nature. They can only be distributed in anonymised formats by the Legal Aid Agency (LAA).

7. Conflict of Interest Statement

There is no conflict of interest to declare.

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